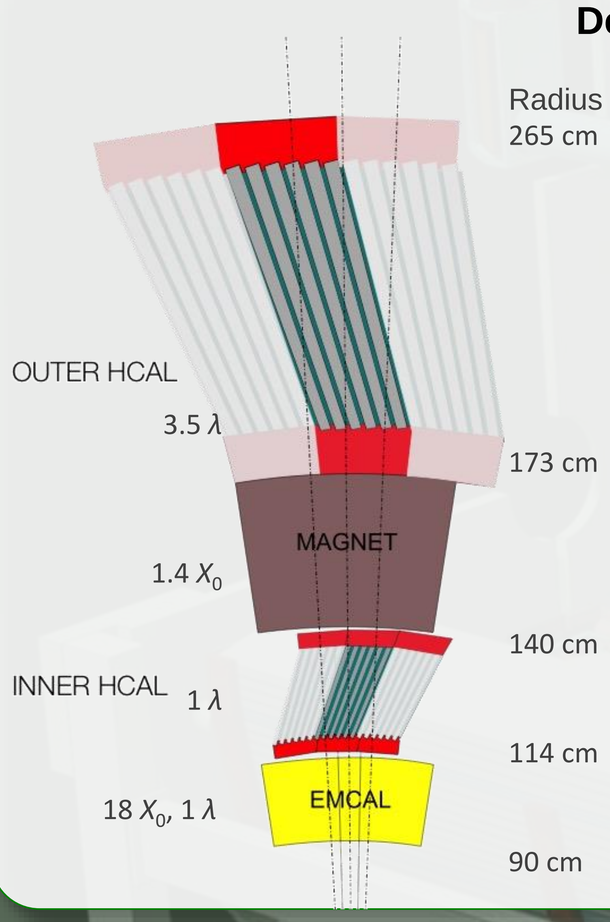
Design and test-beam performance of the sPHENIX calorimeter system

Jin Huang, BNL, *for the sPHENIX Collaboration*

Abstract

The sPHENIX Collaboration at RHIC is planning a major upgrade to the PHENIX experiment by constructing an entirely new spectrometer based on the former BaBar solenoid magnet that will enable a comprehensive study of jets and heavy quarkonia in relativistic heavy ion collisions. The calorimeter system of the sPHENIX experiment will cover an acceptance of ±1.1 units in pseudorapidity and full azimuth with a tungsten-scintillating fiber electromagnetic calorimeter, surrounded by two layers of steel-scintillator sampling hadronic calorimeters. The first prototype of this integrated calorimeter system has been tested at FermiLab in April of 2016, while the second prototype is taking data at this moment. Design considerations, test beam results and performance projections for the sPHENIX calorimeter system are presented in this poster.

Design



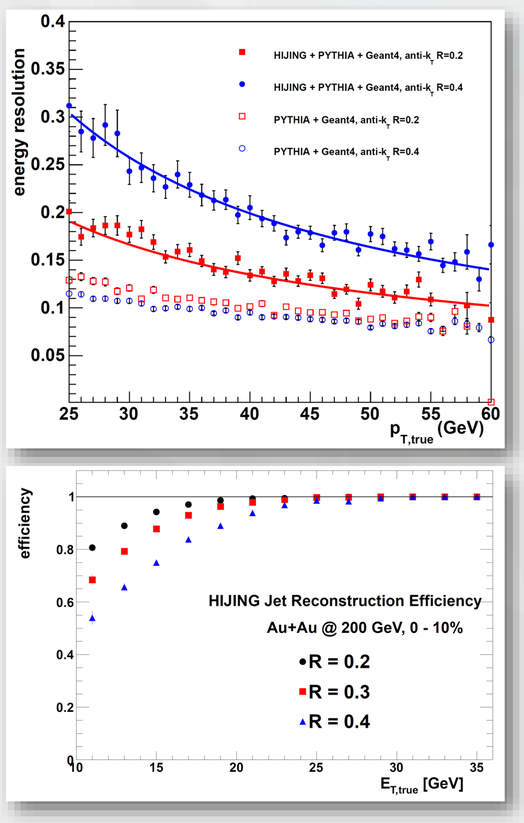
Goal: trigger and detection of jets, photon and $\Upsilon \to e^+e^-$ in heavy ion collisions.

Calorimeter system design:

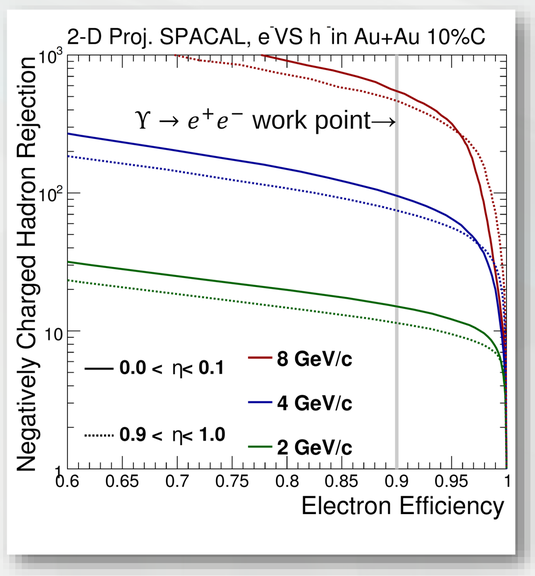
- Coverage: $|\eta| < 1.1$ and full azimuth
- EMCal:
  - ❑ Tungsten-scintillating fiber sampling, ~ 10 g/cm^2
  - ❑ X_0 ~ 7mm, R0 ~ 2 cm
  - ❑ $\Delta\eta \times \Delta\phi = 0.025 \times 0.025$
  - ❑ Electron $\Delta E/E \leq 15\%/\sqrt{E}$
  - ❑ Attempting first projective design
- Hadronic calorimeters:
  - ❑ Steel plate-scintillator sampling calorimeter with wavelength shifter readout
  - ❑ Two longitudinal segments
  - ❑ $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$
  - ❑ Pion $\Delta E/E \leq 100\%/\sqrt{E}$
- Fast and uniform common readout with SiPM and waveform digitizer (Posters of Eric Mannel and Martin Purschke)

Calorimeter Performance in Simulation

Jet energy resolution and efficiency



Electron identification



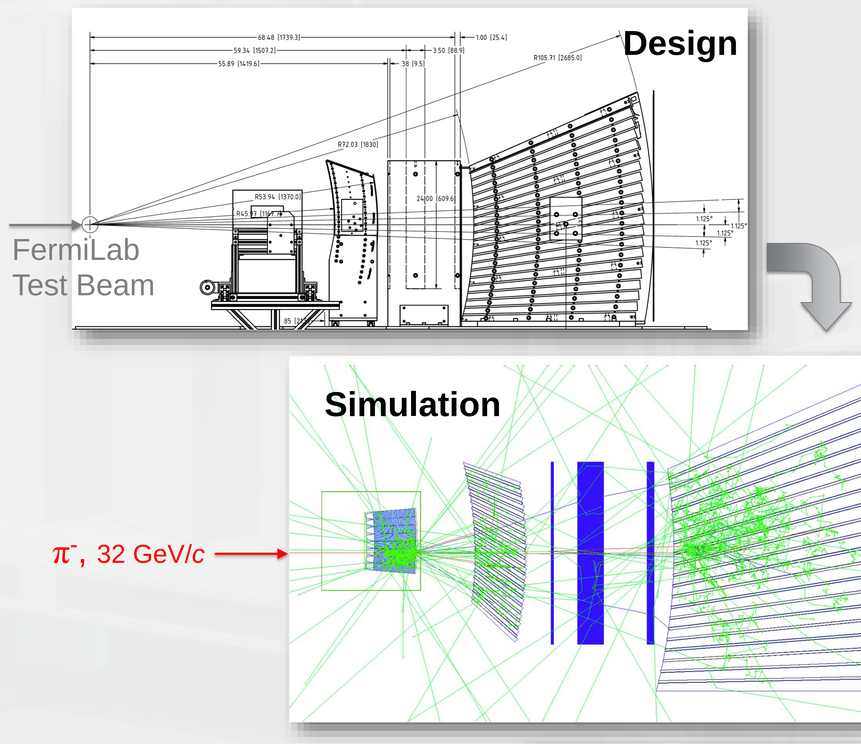
Follow more on physics performance projections:

- Talk of Megan Corners (Wed, A.M.)
- Poster of Krista Smith, Rosi Reed, and Haiwang Yu

Conclusion/Outlook:

- Simulation shows calorimeter design satisfies requirements of physics program.
- Updating studies as design refines and tuning based on the test beam results.

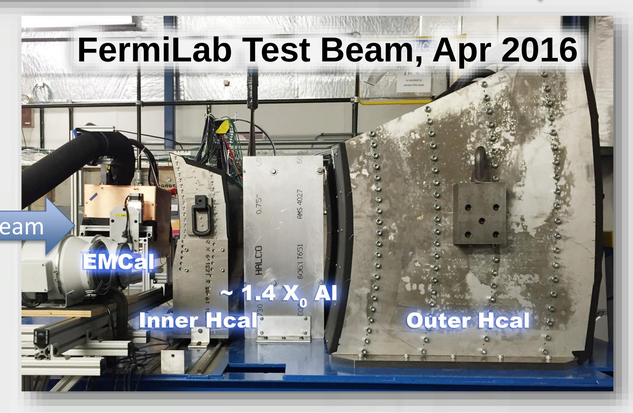
Prototypes, from design to reality



2016 beam test:

- First test of sPHENIX calorimeter system
- Focus on η ~ 0 region
- Goals: understand construction and characteristics of sPHENIX calorimeters

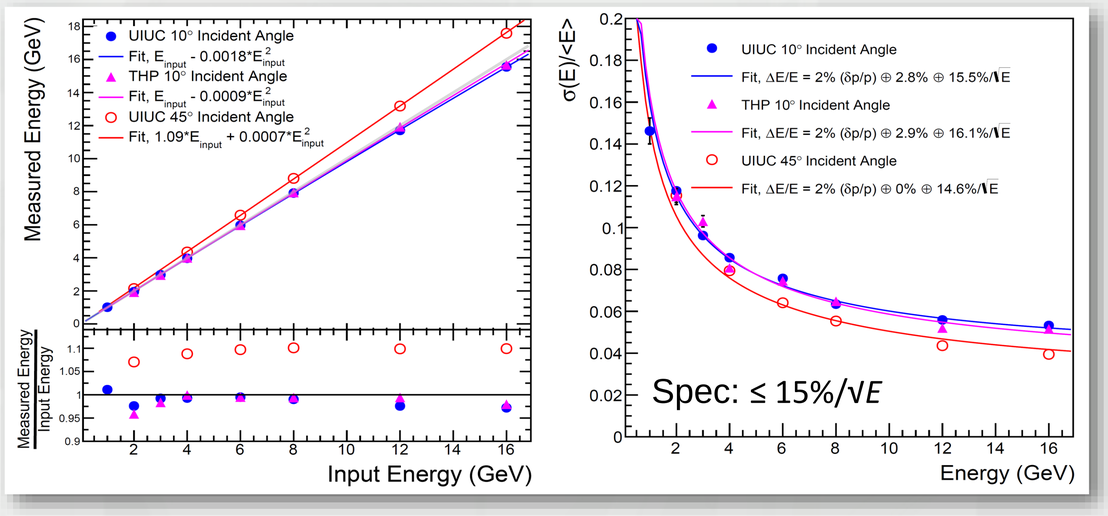
2017 beam test is on going with focus on region near η ~1



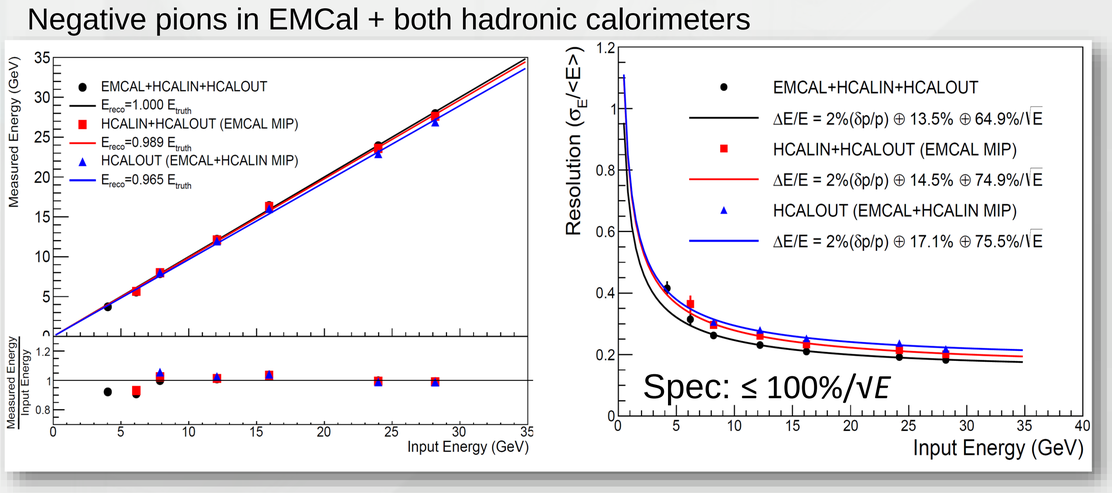
Overview of test beam results

Linearity

Electrons in EMCal



Negative pions in EMCal + both hadronic calorimeters



Conclusion/Outlook:

- Exercised construction of calorimeters and electronics.
- Observed performance satisfied sPHENIX specifications for calorimeters.
- High pseudorapidity test in Jan-Feb 2017, results soon!

For more on the prototype and test beam results :

- Posters of Abhisek Sen, Jamie Nagle, and Virginia Bailey

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